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Mini-Review

Specific Acid-Etched Dental Enamel -The Relationship with Functional Units

Michel Goldberg

Department of Dental Medicine, Paris Descartes University, France

***Correspondence to:** Dr. Michel Goldberg, Department of Dental Medicine, Paris Descartes University, France.

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The structure of dental enamel integrates different levels of functional units, displaying complexity. Rods, synonymous of prisms, and interrod, synonymous of interprismatic substance, are the constituting elements of the assembly of calcium/phosphate monocristals elements in dental needle-like HAP [$(Ca_{10}(Po_4)_6(OH)_2$]. Dental enamel has an internal void volume of 0.2-5%.

The initial inner enamel is about 40µm thick and comprise in an inner enamel layer that consist of an layer (4µm thick), along the dentino-enamel junction, which contains a few rows of oval-shaped rod profiles.

The outer enamel layer is about 20-30µm thick, formed by the outer enamel proper and a 2-4µm thick final enamel layer, where all the crystallites are parallel forming a non-prismatic or prismless (aprismatic) enamel. Prism-free enamel is 40% (mandibular) and 47% (maxillary) with a mean thickness of about 30µm. Surface parallel laminations were frequently observed. The presence of a dislocation line is parallel to the c-axis of enamel apatite. The c-axis was almost perpendicular to the enamel surface. For the deciduous teeth, the crystalline orientation differed from that of the underlying enamel by 26.9° ± 7.6°.

Three pattern of prismatic enamel have been recognized: Pattern 1, prisms are completely surrounded by the prism sheath, and forming a hexagonal pattern. In pattern 2, the prism sheath is open basally. In pattern 3 the prisms form in alterning position (arcade-shaped prisms).

Hunter-Schreger (HS) bands are organized in diazone and parazone, forming light and dark bands. The HS bands are visible namely in the inner prismatic enamel, and vary from 1 single prism is some species to 30 prisms [1]. The diazone and parazone differs by their orientation, at right angles between them, but not by their composition. It is a specific mode of prism decussation.

Rods and interrods consisted of aggregated tubular subunits, 250Å in diameter [2]. A slow two stages secretion-maturation process forms enamel. The birth process influences the formation of the neonatal line in primary tooth enamel. Dissolution by EDTA occurred preferentially at the peripheral border of the prisms.

Daily cross-striations occur in a regular period, and about every nine days they contribute to the formation of Retzius lines, terminating at the enamel surface as perikymata. The angle between prisms and the enamel surface is about 15°, and between Retzius lines and enamel surface is about 45°. Hypomineralized bands form them. Prismatic enamel is present, namely in most mammalians. Major structural discontinuity between prisms and interprisms is synonymous with prism sheath, where most of the organic components are recognized to accumulate [3].

Enamel proteins: amelogenin (18- to 25kDa), ameloblastin (65kDa) enamelin (180-190kDa), enamel proteinases (Enamelysin- MMP20- 45- 41kDa) kallikrein-4 (KLK4, 34- 31kDa also designated as enamel matrix serine proteinase 1 (EMSP1) [4]. The most immature enamel contains about 15-20% proteins by weight, whereas the most mature contains 0.1% protein or less.

Acid-treatment influences the hollow core; it has an average diameter of 37nm. Crystallites have a central defect of 37nm. They are split into two parts of approximately 15nm in diameter. MPa ± SD is for human dentin 17.34 ± 4.93 and for enamel 25.43 ± 6.60. Preferential dissolution results in the complete removal of the surface aprismatic enamel. Minimal or mild etching patterns leads to the formation of surface and sub-surface microporosities that results in a mixed zone of enamel hybridization (8-10μm thick). Intracrystallite resin infiltration appears in the carbonate-rich crystallite core. A compact hypermineralized radiopaque zone up to a depth of about 30μm characterizes the surface zone of enamel.

The softened enamel below the acid-etched enamel has a thickness about 10-20μm, forming bands with indented profile The penetration of resin below the surface enhances the adhesive properties of the restorative material. Resin tags penetrate significantly from 12μm to 22μm, depending on the phosphoric acid concentration. Type I etching pattern dissolved rod enamel, and the interprismatic substance forms a continuous honeycomb. Type 2 etching pattern includes dissolution of interrod substance, rods being less affected. Pattern 3 is due either to the presence of aprismatic enamel, or to solubility resistance due to the presence of fluoride [5,6]. EDTA or other chelating solutions remove exclusively interrods, whereas rods display better resistance and longer tags. The preferential dissolution of rods or interrods creates structures that contribute to enhance the adhesive properties of dental resins.

The complex structure of prismatic enamel allows specific dissolution of rods or interrods. The aprismatic outer layer melt under the influence of acid or chelators, and provides a flat surface, that display reduced properties of resin adhesion. In contrast the prismatic structure leads to the formation of tags and porosities, beneficial to the anchorage of restorative resins to the etched dental enamel.

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